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TRANSFER AND USE OF TRAINING TECHNOLOGY IN AIR FORCE TECHNICAL TRAINING

A MODEL TO GUIDE TRAINING DEVELOPMENT

HUMAN RESOURCES RESEARCH ORGANIZATION
ALEXANDRIA, VIRGINIA

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Transfer and Use of Training Technology in Air Force Technical Training:

A Model to Guide Training Development

Edgar M. Haverland

HUMAN RESOURCES RESEARCH ORGANIZATION
300 North Washington Street ● Alexandria, Virginia 22314

Final Scientific Report for Period 1 August 1973 - 31 August 1976

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The training development process was studied as it was applied in six different training development efforts in Air Force technical training settings over a period of eight months. A previously developed model for matching training approaches with training settings was revised, and suggestions were made for its use in training development efforts. A number of general comments on training development in Air Force technical training are included in the report.

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Edgar M. Haverland

SUMMARY AND IMPLICATIONS

Objective

The objectives of the work described in this report have been to examine carefully the training development process, as it is carried out in Air Force technical training settings, and to revise the model for matching training approaches with training settings so that its usefulness to Air Force training developers is increased.

Approach

The approach taken in this work was to select six training development efforts being carried out in Air Force Schools of Applied Aerospace Sciences, discuss these efforts with the personnel involved periodically over a period of eight months, and obtain training documentation as it became available.

The six training development efforts selected were:

(1) Air base ground defense courses, Lackland AFB

(2) Electronic fundamentals portion of course on maintenance of cryptographic equipment, Lackland AFB

(3) Intermediate level maintenance courses for F 15 avionics systems, Lowry AFB

(4) Materiel control aircraft/ICBM course, Lowry AFB

(5) Modularized instructional system development course, Sheppard AFB

(6) Transportation officer course, Sheppard AFB

The previously developed model was based on the concepts of "training approach" and "training setting", which were intended to include all factors that should be considered in developing training. The concept of training approach includes any method, technique, device, or system considered for use in training. The concept of training setting covers all elements of the training agency or establishment, including resources, policies, training content and student characteristics. The format of this version of the model involved two parallel sets of questions, one set dealing with the training approach and the other set with the training setting.

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Results

The revision of the model involved three major changes:

(1) Consolidation of the two sets of questions into one set, for brevity and more flexible usage. The concepts of training approach and training setting are retained in using the model.

(2) Division of the model into Stages I and II, corresponding respectively to early activities in the training development process, which culminate in the Training Plan, and to the actual development of plans of instruction, lesson plans, study guides, etc.

(3) Addition of specific guidance on the implications of different kinds of training content for choosing training approaches.

In addition, some general observations were made on practical exigencies of the training development process, as it was observed in operation, and on the backgrounds of Air Force training developers and their perceptions of the policies and constraints within which they work.

The revised model is presented, with suggestions for its use in Air Force training development efforts.

PREFACE

This report describes work performed by the Human Resources Research Organization under Research Project AFTEC, Basic Research Relevant to Air Force Technical Training, for the Air Force Office of Scientific Research.

The research was conducted at HumRRO's Eastern Division, Alexandria, Virginia. Dr. J. Daniel Lyons is Director of the Division, and Dr. Edgar M. Haverland is principal investigator for the project. Other work in the project has been done at HumRRO's Western Division at the Presidio of Monterey, California.

The cooperation of Headquarters, Air Training Command, Randolph AFB; and of the Schools of Applied Aerospace Science at Lackland AFB, Sheppard AFB, and Lowry AFB is gratefully acknowledged.

This project has been conducted for the Air Force Office of Scientific Research (AFOSR) under Contract No. F44620-74-C-0007. This report has been submitted to AFOSR as a Final Scientific Report.

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Chapter 1

INTRODUCTION

This is the concluding report on a project entitled, "Basic Research Relevant to U.S. Air Force Technical Training," which has been supported by the Air Force Office of Scientific Research under Contract No. F44620-74-C-0007. The project has been focused generally on the training development process, and has sought to facilitate the effective use of training technology by developing a model for evaluating training approaches or innovations against the requirements and constraints of particular training settings. This model is referred to as the "AFTEC model."

Phase I of the project began 1 August 1973 and ended 31 August 1974. In this phase an initial version of the AFTEC model was developed and subjected to criticism by Air Force training developers and designers in the Technical Training Centers. The revised model incorporating these criticisms is presented in a Technical Report (Haverland, 1974) which describes the activities and accomplishments of Phase I of the project.

Phase II of the project extended from 1 September 1974 to 31 August 1975. During this phase of the project it was planned to use the AFTEC model to select a training setting (course) in which to implement the peer instruction training approach (Weingarten, Hungerland and Brennan, 1972). However, the peer instruction training approach became the object of intense interest by Air Force training agencies, and in order to sustain and satisfy this interest, the selection of the course and the development of the peer instruction system was accelerated and given high priority. The result was that the model was not used to select the course, and the peer instruction part of the project took on a life of its own. Late in Phase II the work of the project was separated into two parallel sub-projects; one dealing with the implementation of the peer instruction system in the Communication Center Specialist Course (3ABR29130) in the School of Applied Aerospace Sciences at Sheppard AFB, and one in which further work with the AFTEC model was undertaken. Most of the effort in Phase II was spent on the peer instruction work. Activities and accomplishments during Phase II are described in more detail in an Interim Scientific Report (Haverland and Hungerland, 1975).

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Phase III of the project has extended from 1 September 1975 to 31 August 1976. During this period the work with the peer instruction system was completed and has been reported separately (Hungerland, Taylor and Brennan, 1976). The work with the AFTEC model during Phase III is the subject of this report.

Objective

The general objective of the project has been to facilitate the effective use of training technology through the development of a model for matching training approaches or innovations with specific training settings. The specific objectives of Phase III activities in the project have been to examine closely the training development process as it is carried out in Air Force technical training, and to revise the AFTEC model so that its usefulness to Air Force training developers is increased.

Definitions

The first version of the AFTEC model was based on the two complementary concepts of training approach and training setting. In developing these concepts, an attempt was made to consider all the elements involved in training, and divide them into two categories; the training approach and the training setting.

The concept of training approach includes any method, technique, device or system considered for use in training. Examples of training approaches include the following: a self-paced learning system, a performance-oriented training system, a peer instruction system, a sound-slide system for instruction, performance testing, a learning center system utilizing carrels and modular instructional packages, the lecture method, the discovery method, and the Socratic method. More than one of these training approaches may be combined with performance testing on criterion objectives to yield an integrated and comprehensive training approach. As a further example, the peer instruction system (Weingarten, Hungerland and Brennan, 1972) includes thorogoing performance orientation of the learning activities, and performance testing, in addition to peer instruction.

The concept of training setting covers all elements of the training establishment, including resources, policies, training content, and student characteristics. A training setting can be defined to cover a whole course,

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a major portion of a course, or a small segment of instruction dealing with a particular topic or skill, as may be appropriate for the particular training development situation. Elements of a training setting include:

    (1)   The financial, physical and personnel resources of the training organization: funds, buildings and equipment; and instructional and support personnel.

    (2)   Policies and requirements of the training agency, and of the organizations and commands it serves.

    (3)   The training content, as described in training objectives in the Plan of Instruction (POI), the list of tasks in the Training Standard (STS or CTS), or latent in the field requirements waiting to be investigated.

    (4)   The abilities, previous experence, physical characteristics, and attitudes of the students to be trained.

The AFTEC model consisted of questions that were designed to obtain information about the training setting, and to require the training developer to evaluate in a specific fashion how well the training approach being considered would "fit" the training setting. A training approach which fit or matched the requirements and constraints of the training setting was considered to be one that would be suitable to use in developing training for that setting.

Training development is considered to be a process that begins with the tentative decision to prepare or substantially revise a course of instruction, and proceeds through the activities of preparing the Training Plan, including a Training Standard and a Course Chart; and preparing the Plan of Instruction, tests, study guides, work books and lesson plans that finally define and embody the course. It involves primarily Step 4 of the Instructional System Development model (Plan, develop and validate instruction), but includes some of the activities of Step 2 (Define education or training requirements) and Step 3 (Develop objectives and tests).

In Phase I of the project the first version of the AFTEC model was initially constructed mainly with the varieties of possible training approaches in mind. When this version of the model was applied to training

settings, some difficulties were encountered, which are described in earlier project reports (Haverland, 1974; and Haverland and Hungerland, 1975). Consequently, in Phase III of the project, the emphasis has been shifted to the training setting, and the model revised to shape it in accordance with the realities of training settings in Air Force technical training.

Scope of This Report

This report describes the work done on the AFTEC model during Phase III of the project. The general approach taken in this work was to select six training development efforts at three different Schools of Applied Aerospace Science, and to observe the work of Air Force training developers, closely interacting with them and discussing the nature and problems of the training development process. From the information thus gathered from Air Force training developers, general observations and comments on Air Force training development will be presented. The modifications made in the model, from the Phase I version, will be discussed, and suggestions made for the use of the model. Finally, the revised version of the model is presented.

Chapter 2

SELECTION AND STUDY OF TRAINING DEVELOPMENT EFFORTS

Near the end of Phase II of the project, after the work with the AFTEC model was separated from the peer instruction work, an assessment of the status of the model showed that its applicability to training settings needed to be explored and developed. Efforts to apply the model to training settings had showed that a thorough-going application of the model to a training setting required a very large amount of information. The selection of the training setting (course) in which the peer instruction system was implemented had shown that certain critical factors sometimes virtually determined the choices made in training development efforts. And finally, applications of the model to training settings had shown that drawing inferences from the kinds of training content to the kinds of training approaches or methods that should be used involved uncertain and incomplete processes. These problems with the model are discussed in more detail in the Interim Scientific Report (Haverland and Hungerland, 1975, pp. 4-6).

Accordingly, it was planned that in Phase III of the project, a variety of training development efforts would be examined closely and the model revised to make its application to training settings more feasible and satisfactory.

Selection of Training Development Efforts

The following criteria were used in selecting six training development efforts to observe and work with in this project:

1. The training development effort was a real effort, Air Force personnel were working on it, and decisions were being made concerning training approaches to be used in actual training.

2. The Air Force personnel working on the training development effort were interested in this project and willing to have HumRRO personnel working with them.

3. At least one of the training development efforts should involve short, low-volume transient courses.

At the end of Phase II of the project and early in Phase III, visits were made to the Schools of Applied Aerospace Sciences at Lackland AFB,

Lowry AFB, and Sheppard AFB. Discussions were held with personnel in the Training Plans Sections of School Headquarters, and in the Curriculum Sections of several instructional departments. As a result of these discussions the following six training development efforts were selected:

1. Revision of three air base ground defense courses (3AZR81150-4, 3AZR81170-2, and 3OZR8124-1), in the Combat Studies Branch of the Department of Security Police Training, Lackland AFB.

2. Revision of the electronic fundamentals blocks of the course on maintenance of cryptographic equipment (3AQR30020-4), in the Department of Cryptographic Training, Lackland AFB.

3. Development of intermediate level maintenance courses for F-15 avionics systems (3ALR32630-2, 3ALR32631A-001, and 3ALR32631B-001) in the Avionics Aerospace Ground Equipment Training Branch of the Department of Avionics Training, Lowry AFB.

4. Development of the Materiel Control Aircraft/ICBM Course (3AZR64550-5) in the Department of Logistics Training, Lowry AFB.

5. Development of the modularized instructional system development course in the Instructor Training Division, Sheppard AFB.

6. Revision and development of the Transportation Officer Course (3OBR6051) in the Traffic Management Branch of the Department of Transportation Training, Sheppard AFB.

Discussion of the Training Development Efforts

The revision of the air base ground defense courses was prompted by the threat of terrorist activities, and was being carried out under the pressure of intense high level interest (Air Force Chief of Staff). While the courses are not short or low-volume, this was a quick-reaction training development effort. As might be expected under such conditions, the usual, prescribed instructional development procedures were short-cut and many decisions concerning training approaches were made in conferences of representatives of Hq, USAF; Major Commands; Hq., ATC; and the Department of Security Police Training. The chief of the team charged with developing the revised courses requested additional copies of the Phase I version of the AFTEC model, and the model was used to some extent in the course development work.

The revision of electronic fundamentals training for cryptographic equipment maintenance was undertaken as a part of the general instructional system development program. Specifically, the aim was to get the content more precisely aligned with what was needed in the later blocks of the course, where the maintenance of particular pieces of cryptographic equipment was studied.

The intermediate level maintenance courses for F-15 avionics systems were being newly developed for a weapon-system that was just becoming operational. The training content was highly technical and the projected student volume was quite low. The maintenance concept for the F-15 avionics equipment (which had been decided upon early in the development of the weapon system) involves computerized malfunction isolation for some of the test equipment which was supposed to indicate to the maintenance technician the particular circuit boards that should be replaced. Accordingly, the technical orders did not contain the circuit diagrams, information on theory of operation, or test point data needed to troubleshoot within the circuit boards. Because of this lack of information in the technical orders, the training developers were forced to shift their preferred instructional content and learning activities mix of information and performance considerably in the direction of more performance on the equipment.

The Materiel Control Aircraft/ICBM course was intended to teach supply personnel in using commands, in this case those concerned with aircraft and missile operations, the information and procedures needed so that they could work efficiently with the Air Force Logistics Command installations which supply the operational commands with materiel. In this case, the training developers in the Department of Logistics Training were heavily dependent on personnel assigned from the operating commands, in developing the course.

The instructional system development course was intended to teach people how to carry out instructional system development procedures in detail. It was to be a modularized course so that people could study any or all parts of the course, according to their needs. During much of the time devoted to observing and studying training development efforts in this project, work on this course was at a standstill, awaiting the Occupational Survey Report.

The Transportation Officer Course being developed at Sheppard AFB was an integration of the 11 week Transportation Officer course which had been taught at Sheppard AFB, and a 7 week Vehicle Management Course which had been taught at Chanute AFB. The course was designed to teach a wide variety of information about all three of the major areas in the transportation field: traffic management, aerial ports (military airlift), and vehicle management. A few of the learning activities were of a performance nature, but most were designed to help students acquire and organize a large amount of information which they would need in their work as junior transportation officers.

Information Gathering Efforts

Trips were made by the principal investigator to Sheppard, Lackland, and Lowry AFB's in August, September, and November 1975, and in March 1976. One or two days were spent at each base on each trip. On these visits extended discussions were held with the persons who were working on each of the training development efforts. Also, sample documentation; such as training plans, training standards, course charts, plans of instruction, and workbook and study guide materials; was obtained from the course developers as it became available.

From these discussions a considerable amount of information was obtained about the people who develop or revise instruction in Air Force technical training. In addition a good deal was learned about the organizational influences and constraints which affect their work. This information has served as a background for efforts to revise the AFTEC model so that it would be more useful to Air Force training developers. Some general observations on training development, as it is carried out in Air Force technical training, are also offered.

Observations on Training Development

It was noted previously that decisions on the maintenance concept for the F-15 avionics equipment, made earlier in the development of the weapon system, had constrained the training developers' choices of training content and approaches. Ironically, when the computerized malfunction isolation in some of the complicated test equipment did not prove satisfactory, it was necessary to develop revised Technical Orders which provided circuit

diagrams and information on theory of operation, and circuit board extenders
so that maintenance technicians could locate and repair malfunctions within
individual circuit boards. Accordingly, it was necessary also to revise
some of the training, after it had been developed and implemented. Generally,
this appears to be a problem involving larger scale procedures for developing
major weapons systems, and would not be soluble at the level of the training
development process.

The typical airman or officer at the working level in Air Force train-
ing development has come to this position with a combination of field exper-
ience in the specialty and experience as an instructor in the School.
Civilians will usually have served as an instructor in the School, but may
not have had field experience, except perhaps some years earlier during
military service. Airmen and officers will often have been students in
courses similar to those they are developing, but usually this student ex-
perience will be five to fifteen years old.

The repertory of training methods and approaches available to most
training developers is limited to those he or she has experienced as a stu-
dent, on the job in the field, or as an instructor in the School. Therefore
the usual tendency is to develop training in the image of the training he
or she has experienced as a student and instructor, conditioned of course
by currently applicable regulations.

A number of training developers have been exposed to different instruc-
tional methods and approaches, some in non-military technical schools or
community colleges, and some in college courses in education or instructional
technology. However, their perception usually is that there is little free-
dom to introduce innovations into Air Force technical training, because of
the several levels of evaluation and approval (usually traditionally oriented)
which their proposed training materials must pass. These levels of approval
start at the department curriculum unit and go on up the hierarchy.

Occasionally, a decision will be made at a high level (Headquarters,
Air Training Command) that, say, self-pacing is a desirable feature in
training, and Schools will be urged to self-pace their courses. When this
is done, and the word gradually permeates the inspection and evaluation

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elements of the Headquarters, the pressure on the Schools to fall in line becomes intense. This often leads to uncritical acceptance and implementation of the suggested instructional approach, sometimes in an inferior form, and sometimes in an inappropriate setting.

The ideal would be to have training developers acquainted with a wide range of possible training approaches, and to have them free to judiciously apply these approaches in the training they develop. They should be guided mainly by reasonable cost limitations and the effectiveness of the resulting training. The training developers encountered in this study were skilled and conscientious. Knoweldge of a wider range of possible instructional approaches and freedom to responsibly choose among these approaches would enable them to do a better job of developing training.

distinct stages. Stage I of the process involves the preliminary planning in which the number of students to be trained, the major resources needed, and a general outline of the training content are decided upon. The product of Stage I of the training development process is a Training Plan, usually including a Course Chart and a Training Standard. The procedures and requirements for Training Plans are described in ATCM 52-1 (Air Training Command, 1969). Following the completion of the Training Plan there is usually a period during which higher level approvals of the training plan and authorizations to proceed with the preparation of detailed training materials are obtained. Then Stage II activities are undertaken. These Stage II activities involve preparation of a detailed Plan of Instruction, lesson plans, study guides, work books, etc.

An examination of the Phase I version of the AFTEC model showed that it involved both Stage I and Stage II training development activities, mingled together with no recognition of the two-stage process described above. Accordingly, the revised version of the model presented in this report is divided into two stages. The kinds of questions involving numbers of students, major resources needed, and the general outline and content of the training to be developed are placed in Stage I of the model, and the questions concerned with the activities of instructional personnel, the characteristics of students, and the specific implications of the training content for the kinds of learning activities that should be provided in the training are placed in Stage II.

Specifically, the question in the training content section of Stage I of the model which asks,

> "What tasks must the student be able to perform when he finishes training and to what level of proficiency must the student perform on each task? What kinds of knowledge about each task should the student have?"

refers to the preparation of the list of tasks for the training standard.

Addition of Guidance on Implications of Training Content for Training Approaches.

Problems in inferring from the kinds of training content to the kinds of training approaches that should be used were noted in the Interim Scientific Report (Haverland and Hungerland, 1975, pp. 5-6). Gagne (1970) has

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Chapter 3

REVISION OF THE AFTEC MODEL

The Phase I version of the AFTEC model (Haverland, 1974) consisted of
two parallel sets of questions. One set of questions dealt with the train-
ing approach being considered, and the other set with the training setting.
The questions covered such topics as the objectives sought in developing
or revising the training, the resources (funds, materiel and facilities,
and personnel) required, instructional design and management, the character-
istics of the training content and the characteristics of the students.

Consolidation of the Questions Into One Set

The two parallel sets of questions in the Phase I version of the model
covered the same topics, one set being worded so as to focus attention on
the requirements and implications of the training approach being considered,
and the other set worded so as to focus attention on the resources and per-
sonnel available in the training setting, and on the requirements and con-
straints that the training setting would impose on the training to be de-
veloped. In fact, in nearly all cases, corresponding questions on the two
"sides" of the model were paraphrases of each other. This format was used
in an attempt to require the training developer to use the concepts of
training approach and training setting, and to seek a match between them as
the method of making decisions concerning the general form that the training
to be developed should take.

This two-sided format produced a bulky and repetitive model. The for-
mat of the model presented in this report has been revised so that it con-
sists of one set of questions, with attention being directed to the training
approach and the training setting by space for notes concerning the training
approach on the left side of the page, and space for notes concerning the
training setting on the right side of the page.

Division into Stages I and II

Observation of the training development process in Air Force technical
training showed that the activities involved are often divided into two

attempted to provide general guidance for making these kinds of inferences, and Air Force guidance on this problem, AF Pamphlet 50-58 (Department of the Air Force, 1973), follows Gagne. Training content, and the kinds of training approaches that should be used, are discussed in AFP 50-58 (Volume IV, Chapter 3) using the following categories:

Motor Chains

Verbal Associations and Chains

Discriminations

Classifications

Rule - Using

Problem-Solving

However, these classifications of performance are several degrees of abstraction removed from the kinds of performance required of students, as perceived by Air Force training development personnel.

In discussions with training development personnel, it was found that only one or two of the most sophisticated and better educated persons were familiar with and able to use *this set of classifications* in deciding on the kinds of training approaches to use for various kinds of training content. For most training development personnel, the degree of abstraction involved in *this set of classifications* was apparently too great for them to be able to use it in classifying the training content they were dealing with, and then to go on and follow the suggestions for deciding on the training approaches to be used.

Gagne and Briggs (1974) use a set of categories that is even more general and abstract.

In the Phase I version of the AFTEC model the attempt was made to make the categories suggested for classifying training content more concrete by making them somewhat less general and all-inclusive. Also, these categories were labeled with words that were somewhat less abstract, and which had been used in the literature on task descriptions. In addition, two or three specific examples of each type of performance were given. This still left the training developer with no guidance as to the most important features of each kind of content, to which he should give careful consideration in deciding on training approaches. In the latest version of the AFTEC model, as presented in this report; brief, pointed discussions of each type of

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training content are added. In these discussions the most important fea-
tures, for the training developer, of each type of training content are
pointed out, and explicit suggestions are made as to how these features
should influence the choice of training approaches. This still falls con-
siderably short of a logic tree or decision table method of indicating the
kinds of training approaches that should be used for particular kinds of
training content, to which some training developers wishfully referred.

It is the writer's opinion that a logic tree or decision table method
of deciding on training approaches for particular kinds of training content
would be unlikely to cover some of the various possible training approaches
that might be feasible in different training settings. If such a method
were presented, training developers would likely lean on it, and fail to
consider training approaches that might be quite feasible in their training
setting but not in many others.

General Comments on the Revised Model.

The revised AFTEC model has been tailored to fit training development
process, as it was observed in Air Force technical training settings, in
many small ways, in addition to the change to a two-stage procedure, which
has already been discussed. These small changes are mainly in terminology,
since in conversations with Air Force training developers, frequent questions
were encountered about training technology terminology which differed from
that in general use in the Air Force. The Phase I version of the AFTEC
model had been constructed with potential applications in civilian educa-
tion and training in mind, and this sometimes led to the use of terminology
different from that used in the Air Force.

However, one of the subordinate objectives of this project has been to
stimulate and extend the thinking of Air Force training developers, so that
they will consider a wider range of training approaches than they usually
do now. To this end, the revised model has retained a number of features
which go beyond common practice in current Air Force training development.
These features appear in questions which ask about instructor roles in
managing the learning activities of students and in quality assurance
performance testing, for example. Other questions deal with features

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of training approaches not in common use in the Air Force, such as peer instruction.

In developing the Phase I version of the AFTEC model, it had been assumed that detailed and specific training objectives would be available, and that the use of the model would be only in training development activities downstream from this point in the whole process. Observation of the six training development efforts showed that much of the information that the model dealt with was gathered earlier in the training development process. Hence the shift to a two-stage process, with all of the Stage I activities occurring before detailed specific training objectives are written. Actually, it appeared that detailed, specific training objectives are usually hammered out in the process of writing the Plan of Instruction. To be sure, lists of objectives are prepared at earlier stages of the process, in accordance with instructional system development procedures in AF Manual 50-2 (Department of the Air Force, 1975), but the final objectives that actually characterize the instruction in operation are fashioned in the confrontation between what is desired and what is feasible, which occurs during Stage II of the training development process, as it is described above. Accordingly, it is now assumed that in analyzing training content in Stage II, training developers will be working from the list of tasks which had been developed in Stage I for the Training Standard, and will fashion the training objectives as an early part of actually developing the training in Stage II.

In observing Air Force training development efforts, it was observed that a major distinction is made between task performance and task or subject knowledge. This grows out of the prescribed proficiency codes used in the training standards. However, it appears to have major effects on the later choices of instructional and testing methods. For tasks that are given a performance proficiency code in the training standard, it appears that training developers will make substantial efforts to devise methods of teaching and testing that require students to actually perform the activity involved, or something close to it. However, for tasks that are given a knowledge proficiency code, there appears to be much less pressure to train and test in ways that are job-relevant. Information will often

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be presented in lectures that might better have been taught in the context of the job activities for which it is needed, and knowledge tests that do not relate the information to the situations on the job where it is needed are often used. The result is that often the training and testing are less effective than they could be.

In dealing with training content in Stage II of the revised AFTEC model, a heavy emphasis is placed on performance. Knowledge is prominent only in one of the types of training content (Recall and application of facts), and to some extent in Problem Solving, but in both cases the guidance offered emphasizes that the knowledge must be taught in a job-relevant context.

Chapter 4

USING THE MODEL

The revised AFTEC model can be used in several different ways. At one level, it can be used as a general reminder-checklist of things to consider in a training development effort. Stage I of the model would be used, of course, in the activities leading to the development of a training plan, and Stage II in the later, actual development of training materials.

At an entirely different level, the model may be used as a full-fledged procedure for evaluating a proposed training approach or system against the requirements and constraints of a particular training setting. When the model is used at this level, the suitability of the proposed training approach in the particular training setting should be carefully evaluated with respect to each question in the model, and detailed notes and comments written down. A review of these notes and comments will then show the points on which the training approach appears to be particularly suited for use in this training setting, and the points where there may be difficulties or doubts about the suitability or feasibility of the proposed training approach in this training setting. The decision on whether to go ahead and implement the training approach in this training setting may then be made, based on a consideration of these points.

In addition the model may be used as an outline for discussing the features of a training approach in general, and not with respect to a particular training setting. The questions in the model have been selected because they involve points that are important in evaluating the suitability of a training approach for use in training settings. Therefore, these questions should bring out the features of a training approach that are likely to be important in determining how well it works when applied in an actual training setting.

Finally, the model may be used as an outline, if one wished to develop a relatively complete inventory and description of a training setting. For this purpose the model will serve as a good guide to the features of a

training setting that are important for the kinds of training methods or approaches that may be useful in that training setting.

Critical Factors in a Training Setting

In observing training development efforts, it has been noted that there are times when a single factor in a training setting may have extra-ordinary weight in decisions that are made concerning training appraoches. Major equipment or facility shortages, pressure from a higher level head-quarters, or the costs of going to a third or fourth shift training opera-tion are possible examples of such factors.

It is suggested that an effort be made early in any training develop-ment project to identify any factors which are likely to have extraordinary influence on decisions made during the training development process. The AFTEC model may be useful in this effort, since it covers many factors that are usually important in training development decisions. However, unusual circumstances may exist, so that a factor that ordinarily would not be of great importance may be very important in this particular training setting. Thus certain courses of action may be practically dictated, or certain training approaches ruled out, in the beginning, by the weight that such an unusual factor has in the training setting. It is recommended that the proposed training development effort be carefully reviewed by a person who is quite familiar with resources, policies, and personalities of the training setting, to see whether any such critical factors are present. The model can be reviewed with this objective in mind, but an effort should be made to go beyond the model and identify any unusual factors that may be of great importance in this particular training setting.

If one or more unusually important factors are identified, their prob-able influence on training development decisions should be estimated. Then the more detailed analyses, using the model, can be modified accordingly. Detailed analyses involved in certain decisions may not need to be done, if the decisions have in effect already been made, based on some unusually important factors in that particular training setting.

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Comparison of the AFTEC Model with the MODIA System

The MODIA system (A Method of Designing Instructional Alternatives) is a comprehensive, highly computerized model for designing instructional systems, and particularly for evaluating by simulation the consequences of decisions concerning alternative features of instructional systems. The MODIA system has been developed over the last several years by the Rand Corporation, and according to recent unpublished working notes, it has grown in complexity during this period. By contrast, the revised version of the AFTEC model presented in this report has been simplified and tailored more closely to the terminology and structure of current training development efforts in Air Force technical training.

It appears to the writer that the MODIA system will require, in addition to substantial computer capacity, a corps of experts in the method (referred to as "the MODIA team"), and extensive orientation to the system of a large group of subject matter experts cum training developers who are dispersed throughout the instructional departments of Air Force Schools. This orientation will need to focus specifically on the sets of categories established in the MODIA system for the types of learning events, subject matter, teaching formats, etc., so that these persons can supply suitable input materials to the MODIA team, and then make constructive use of the output from the system. Thus, implementing the MODIA system will require a very substantial training and orientation effort. The present version of the AFTEC model is designed specifically to be useful to present training developers in Air Force technical training settings, working under present conditions, and should not require any special training and only a minimum of orientation.

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Chapter 5

THE REVISED MODEL

The revised model is presented in this final chapter. The reasons
for the revision, and a discussion of the differences between the revised
model and the Phase I model (Haverland, 1974) are presented in Chapter 3
of this report. Suggested uses for the model are presented in Chapter 4.

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Stage I of the model is intended to be used early in the process of planning and developing training. It deals generally with the kinds of questions that must be answered in developing a Training Plan, according to ATCM 52-1 (Air Training Command, 1969). The activities involved in answering the questions in Stage I of the model include developing the list of tasks for the Training Standard, and blocking out the major sections of the training course to be developed, as in a Course Chart.

The following is an outline of the major headings in Stage I of the model:

OBJECTIVES

RESOURCES
    A. Funds
    B. Instructional equipment, materials, and facilities

INSTRUCTIONAL DESIGN AND MANAGEMENT
    A. Instructional pacing and individualization
    B. Fixed, standard level of proficiency expected of each student
    C. Requirements for Management information

INSTRUCTIONAL PERSONNEL
    A. Number of instructors needed
    B. Skills or experience needed by instructors

STUDENT CHARACTERISTICS
    A. Numbers of Students
    B. Students from foreign countries, or other Services

TRAINING CONTENT
    A. Performance and knowledge requirements
    B. Organization of training content
    C. Appropriate kinds of instructional activities
    D. Frequency and extent of likely changes in training content

OBJECTIVES

What are your objectives in developing or revising this training? What goals would you like to see the training system attain? What problems do you see in the training system that need to be solved? The following list describes some goals that might be achieved in developing or revising this training. Others should be added if needed.

● Improve job performance of graduates
● Reduce student attrition
● Individualize training
● Save training time
● Reduce training costs
● Adapt course to students of lower (or higher) aptitude
●
●

RESOURCES

A. Funds

1. Will capital expenditures, for such items as new or renovated buildings or training equipment, be necessary in developing or revising this training?

2. What operating expenses, such as maintenance of equipment and facilities or consumable supplies, will be required for the training to be developed?

3. What are the training development expenses likely to be for such activities as job analysis, training content analysis, development of training system, and development of the training materials), both originally and whenever changes in training content or policies make it necessary to partially repeat the training development process?

4. Can the training to be developed share facilities or equipment with other courses, or with operational units?

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B. Instructional equipment, materials, and facilities

1. What types or locations of training are involved in the training to be developed? Possible types or locations of training are listed below. Others should be added to this list, if they are needed.
   - Formal school training, of a continuing nature
   - Special school training, of a one-time nature
   - Basic military training
   - On-the-job training
   - Learning Resource Center
   - Dispersed locations
   - Remote sites
   -
   -

2. Space required for training

   a. What kinds of space are needed for the training to be developed? How much of each kind of space is needed? Examples of kinds of space:
      - Classroom
      - Laboratory
      - Practical exercise facilities
      - Outdoor ranges or maneuver areas
      - Storage
      -
      -

   b. Does the training to be developed require that the space to be used have special characteristics or utilities? Examples:
      - Electric power requirements
      - Air conditioning and ventilation requirements
      - Lighting requirements
      - Floor loading capacity
      -
      -

   c. Are environmental extremes, such as heat, cold, humidity, etc., likely to be a problem in the training to be developed?

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d. What elements in possible training
approaches are related to space needs?
Possible elements include:
- One classroom for each Class of
  _____ students
- One terminal for each student using
  the system
- One learning station for each module
  of content
- One set of equipment for each group
  of students
-
-

3. Equipment and Materials

a. What kinds and amounts of equipment from
the field will be needed to conduct the
training? Does this equipment need to be
operational, or can it be non-operational?

b. What kinds and amounts of training equip-
ment or materials will be needed for the
training? The following list suggests
some kinds of training equipment and
materials that may be needed:
- Audio-visual equipment
- Films
- Audio and video tapes
- Training aids (charts, transparencies,
  cut-away equipment, mock-ups, etc.)
- Part-task training devices
- Simulators, of various fidelity levels
- Study guides, Technical Orders, or
  other printed training material.
- Job performance aids.
-
-

c. Can the training to be developed be
accomplished in a manner so that some
equipment now on hand can be turned in?

4. Factors affecting the management of instructional
equipment and materials.

a. What resources (funds, skilled personnel,
tools and equipment, etc.) will be needed
to maintain the equipment to be used in
the training?

b. Will training materials or equipment
with security classifications be needed
to conduct the training?

c. Will it be necessary to use copyrighted
materials in the training? If per-
mission is needed, can it be obtained?

d. What are the lead times required to
obtain the equipment that will be needed
to conduct the training?

e. Will printing of training materials,
or production of other audiovisual
materials be necessary to support the
training being planned? Is base (or
other) support available for these
things? With what lead time?

INSTRUCTIONAL DESIGN AND MANAGEMENT

A. Instructional pacing and individualization

1. How will the progress of individual students
through the instruction be determined? The
following list describes some alternative
methods for pacing instruction:
● Lock step: All students follow a fixed
schedule
● Group pacing: Students progress through
the instruction at a rate determined by
the abilities of a group as a whole.
Groups of homogeneous ability levels
may be formed (multiple tracks).
● Individual or self-pacing: Each student
may proceed at his or her own pace
through the required training activities.

2. Depending on the answer to Question 1 above:

a. If the course of training is to be of
a fixed length for all students, how long
is it to be?

b. If the course of training is to be of
a variable length for different students,
what limits on variation in course length
(if any) should be set?

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3. Will students be given the opportunity to take _proficiency tests_ covering modules or sections of the training content, and if they pass these proficiency tests, will they be allowed to skip the training activities for these modules and move on to other parts of the instruction? This feature is termed, variously, proficiency advancement, modular scheduling, or diagnostic proficiency individualization.

4. Will _extra training materials or activities_ be provided for some portion of the students, so that they can remedy deficiencies in their preparation for the instruction?

5. Will students have a _choice_ (at least part of the time) as to the _methods or media_ they use in studying the training content?

B. Is a _fixed, standard level of skill or proficiency_ expected of graduates of the training to be conducted, or is each student expected to _develop his capabilities as far_ as he can in areas at least partly determined by his own interests?

C. Will it be necessary to gather, summarize and report various kinds of _management information_ for the training to be developed? Have the requirements for privacy and confidentiality of such information been considered? The following list indicates some of the kinds of management information that might be required:
   - Information on students' backgrounds
   - Information on students' progress through the training
   - Information on the adequacy of various parts of the training
   - Information on the adequacy of graduates' performance
   - Information on instructional resource utilization
   -
   -

INSTRUCTIONAL PERSONNEL

A. Number of instructors needed

1. Considering the relevant Trained Personnel Requirement (TPR) and the plans for managing student learning activities, how many instructors will be needed to present and manage the training being developed?

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2. In planning for the development of the
training, has adequate lead time been
allowed for obtaining instructors?

B. What skills or experience should be possessed
by the instructors who will be needed for the
training to be developed? Some of the skills
or experience that might be needed are given
in the following list; other kinds should be
added if needed:
- Proficiency in the subject matter students
  are to learn
- Managing instructor-student relationships
  (classroom management skills, reinforce-
  ment techniques, counseling techniques, etc.)
- Analyzing and critiquing student performance
- Relevant field experience
- Proficiency in instructional system develop-
  ment activities
- Operation of audiovisual equipment
- Computer operation or programming
- Writing skills
- Proficiency in evaluating student performance
- Knowledge of relevant administrative systems
- Operation or maintenance of operational
  equipment
-
-

STUDENT CHARACTERISTICS

A. Numbers of Students

1. According to the relevant Trained Personnel
Requirement (TPR) how many students are to
be trained per Fiscal Year?

2. Will these students be divided into groups
or classes? If so, what size will the groups
or classes be, and at what intervals will they
enter the training? Or will students enter
the training in a more or less continual flow?

3. Do student input rates, or the characteristics
of the available physical facilities have im-
plications for the size of the basic instruc-
tional group (that is; classroom, laboratory
or work group)?

      4. Will the supply of students available to
enter the training likely be <u>stable</u>, or
will it probably <u>fluctuate</u> sharply?

B. Are some of the students from <u>foreign countries</u>,
or from <u>other Services</u>?

TRAINING CONTENT

A. Performance and knowledge requirements

    1. <u>What tasks must the student be able to per-
form</u> when he finishes training, and to what
<u>level of proficiency</u> must the student perform
each task? What <u>kinds of knowledge</u> about
each task should the student have?

      a. Task performance standards:
- Limited performance—can do simple
parts of the task, but needs to be
told or shown how to do most of the
task.
- Partial performance—can do most
parts of the task but needs help on
the hardest parts of the task.
- Competent performance—can do all
parts of the task and needs only to
be spot-checked.
- Highly proficient performance—can
accomplish the complete task quickly
and accurately, and can tell or show
others how to do the task.

      b. Task knowledge standards:
- Nomenclature—can name parts, tools
and simple facts about the tasks.
- Procedures—can name the steps in
doing the task and tell how each
step is done.
- Operating principles—can explain
why and when the task must be done,
and why each step of the task is
needed.
- Complete theory—can predict, identify
and resolve problems about the task.

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2. <u>General knowledge standards.</u> What kinds
of general knowledge about the subject
involved in the training should students
have when they finish training?

- Facts-can cite basic facts about the
  subject
- Principles-can explain relationships
  among basic facts and state general
  principles about the subject.
- Analysis-can analyze facts and prin-
  ciples and draw conclusions about the
  subject.
- Evaluation-can evaluate conditions and
  make proper decisions about the subject.

B. <u>Organization of Training Content</u>

1. <u>Division into blocks or modules</u>

   a. Are there, within the training content
   itself, natural divisions that should be
   considered when dividing the training into
   blocks or modules?

   b. Does the training approach being considered
   provide a basis for dividing the training
   into blocks or modules?

   c. Are physical facilities, such as classrooms,
   laboratory space, and operational or train-
   ing equipment, arranged in a manner that
   would affect the division of training into
   blocks or modules?

2. <u>Sequencing of training content</u>

   a. Must some parts of the training content
   be learned before other parts can be
   learned?

   b. Does the training approach being considered
   have any implications for the sequencing
   of training content?

   c. Is there a need for a flexible sequence
   of training activities (if this is feasible)
   in order to be able to work around bad
   weather or equipment failures, for example?

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C. What kinds of instructional activities appear to
    be appropriate for the training to be developed?
    Examples of several kinds of instructional ac-
    tivities are given in the following list (others
    should be added if they are needed):
    ● Demonstration (presentation of performance)
    ● Practice of performance
    ● Presentation of knowledge
    ● Practice of knowledge
    ● Provision of feedback, or knowledge of
      results, to students
    ● Provision of individual, tutorial assistance
      to students
    ● Evaluation of student performance and
      knowledge

D. Is the training content likely to change frequently
    or substantially after the training has been de-
    veloped and is in use? If such changes can be
    expected, training methods should be chosen and
    training materials developed with this in mind.

STAGE II

Stage II of the model is intended to be used in the actual development of the course, when the detailed decisions are made concerning learning activities for the students. The preparation of a Plan of Instruction, and Study Guides, Workbooks, and Lesson Plans are the major activities at this stage of the training development process.

The following is an outline of tne major headings in Stage II of the model:

INSTRUCTIONAL PERSONNEL
    A. Instructor roles
    B. Auxilliary instructional personnel needed
    C. Instructional personnel management

STUDENT CHARACTERISTICS
    A. Aptitude level of students
    B. Special skills or characteristics required of students
    C. Sex of students
    D. Student motivation problems
    E. Student management

TRAINING CONTENT
    Kinds of learning activities needed in the training
        1. Recall and application of facts
        2. Serial procedures
        3. Tracking and aiming
        4. Searching and scanning
        5. Discrete or continuous performance
        6. Noise filtering
        7. Skilled actions
        8. Discrimination behavior
        9. Complex perceptual-motor behavior
      10. Problem solving

INSTRUCTIONAL PERSONNEL

A. What kinds of activities will the instructors be required to carry out in the instructional system to be developed? Both the training content involved and the training approaches chosen will affect the roles instructors fill in the instructional system. The following list describes some possible roles for instructors; others should be added if necessary:
   - Managing the instructional system (assigning students to learning activities, monitoring training equipment utilization, etc.)
   - Evaluation of student performance (for example, proficiency testing)
   - Monitoring student performance (and intervening when necessary)
   - Presentation of instruction (lecturing, demonstrating)
   - Planning and developing instruction (ISD activities)
   - Conducting discussions
   - Leading student activities
   -
   -

B. Will auxillary instructional personnel be required in the instructional system to be developed? The following list describes some possible kinds of auxillary instructional personnel; other kinds should be added to this list if needed:
   - Proctors (monitoring student activities but not intervening)
   - Administrative clerks (recording and processing data)
   - Training equipment operators and repairmen.
   - Computer operators and programmers
   -
   -

C. Instructional personnel management

   1. If the number of students is increased or decreased substantially, what will be the affect on the number of instructors required?

   2. Will special or additional training for instructors be required, for the training which is to be developed?

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3. What provisions for instructor evaluation
    are to be made in the development of the
    training?

STUDENT CHARACTERISTICS

A. Aptitude levels of students

    1. Will the students who are to enter this train-
        ing be selected so that they fall in a partic-
        ular range on the relevant aptitudes--high,
        middle, or low--or will they be at all levels
        of aptitude?

    2. Will the students be selected for any special
        aptitudes other than the four standard Air
        Force aptitude areas (Administrative, Elec-
        tronics, General, and Mechanical), such as
        athletic, verbal, clerical or spacial
        perception?

B. Special skills or characteristics required of
    students.

    1. What reading level will be needed by students
        who are to enter the training?

    2. What levels of vision, hearing, or other
        sensory acuities will be needed by the students?
        Will color vision be needed?

    3. Will students need to be proficient in certain
        skills, or have had certain kinds of experience,
        in order to enter the training.

    4. Are there any special characteristics needed,
        such as physical stamina, absence of fear of
        heights, volunteer status, Human Reliability
        criteria, absence of speech impediments, manual
        dexterity, exemplary appearance and bearing,
        unusual strength or size, etc.?

C. Sex of Students. Are students entering the train-
    ing to be male or female, or both? Will this make
    any difference in the instruction or facilities
    required? Factors that might be involved include:
    different equipment or clothing requirements for
    women from men, or from those normally used by
    women; latrine facilities; quarters; etc.

D. Student Motivation. Is it likely that a
significant number of the students entering
training will be very poorly motivated be-
cause of malassignment, or for other reasons?
Will provisions for counseling or otherwise
dealing with such individuals be needed?

E. Student management

1. Will it be necessary to provide advance in-
formation on students' graduation dates, if
a self-paced course of training is developed?

2. Will students be required to perform unrelated
extra duties, details, etc. while they are in
training?

3. Will it be important for students to finish
training as soon as possible (in a self-
paced course)? Can incentives be offered to
students who finish training early?

4. How frequent are student absences from train-
ing activities likely to be? Should the
training system provide opportunities for
students to make up missed work?

TRAINING CONTENT

What kinds of learning activities should students
engage in, to insure that they will be able to achieve
the criterion objectives established for this training?

The numbered headings in the material below describe
most of the kinds of activities that may be required.
(Additional headings should be used if needed.) Under
each heading is given two or three examples of that kind
of performance. Then follows a guidance section which
discusses the most important aspects of that kind of
performance, to help in choosing appropriate learning
activities.

1. Recall and application of facts

Examples: Making specific control settings on
equipment from memory (Student must
remember and use information on what
the settings should be.)

Speaking (or writing) with reason-
able fluency concerning an equipment
system (Student must remember the
terminology of the system, includ-
ing the names and locations of the
parts and controls.)

Completing forms required to show
that prescribed maintenance activ-
ities have been accomplished (Student
must remember the format and content
of the information required to com-
plete the forms, and where in the
maintenance procedures or on the
equipment this information can be
obtained.)

Guidance: Activities requiring recall and appli-
cation of facts are usually parts of larger pro-
cedures or activities. Therefore, when students
must recall and apply facts, they will usually
be working on sub-objectives (sometimes called
secondary, enabling, or supporting objectives),
rather than terminal or criterion objectives.
Sometimes such sub-objectives will be adequately
learned as a part of the larger performance
specified by the criterion objective, and no
special learning activities for the recall and
application of facts will be needed. At times,
however, it will be necessary to provide learn-
ing activities specifically designed to aid
students in recalling and applying facts.

If special learning activities are needed to help
students recall and apply facts, it is important
that they "fit" the on-the-job performance. It
may be tempting to require students to memorize
lists of control settings, equipment terminology,
or names of controls. However, such learning ac-
tivities often do not "fit" the required on-the-
job performance well enough so that what the
student learns from these activities will be
usable in carrying out the larger on-the-job
performance.

If it is possible to have the student carry out
learning activities in a setting very similar
to the job, the learning activities will usually
fit the job reasonably well. For example, a
sub-objective may specify:

"Given a model XXX diesel engine in
operating condition, the student will
place the appropriate controls in the

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positions required so that the engine
is ready to start. The student must
place or insure that all controls are
in the required positions in the
proper order without reference to a
manual or printed instructions,
within one minute."

The activities described in this sub-objective
obviously fit the on-the-job performance
reasonably well.

However, it may often be more feasible to have
students carry out learning activities away from
the actual equipment or job situation to aid them
in learning to recall and apply facts. In this
case, it will take some care to insure that the
learning activities fit the on-the-job performance.
Requiring the student to "state orally or in
writing the functions of the controls listed be-
low" would involve learning activities which prob-
ably would not fit the on-the-job performance very
well. When preparing to operate the engine, the
student must decide (or have specified for him)
the first general step to be accomplished, which
in the example being discussed would be, "Start
the engine." Next, the student would need to
know what he must do to start the engine. Then
the sub-objective given below would involve ac-
tivities that generally fit the actual on-the-
job performance, and would require the student
to recall and apply the needed information.

"The student will specify orally or
in writing the controls of the model
XXX diesel engine which are involved
in starting the engine, and the po-
sitions to which these controls must
be set so that the engine is ready to
start. The student must specify the
controls and the positions to which
they must be set in the order in which
the controls must be set to prepare
the engine for starting. The student
is to do this without reference to
a manual or printed instructions,
within one minute."

Specifically, in this case fitting the actual
on-the-job performance means that the general
cues or instructions at the beginning of the
activities are the same or very similar, and
that the order of the activities performed is

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the same as would be required in the actual on-
the-job performance. Actually, the performance
required by this sub-objective would probably
be somewhat more difficult than performance of
the earlier sub-objective on the engine itself,
because the cues provided by the parts of the
engine would be missing. Many of these cues
could be provided with pictures or drawings of
the engine, if desired.

Learning activities for the second and third
examples given above are indicated in the sub-
objectives below:

> "The student shall be able to report
> orally to his supervisor (or instructor)
> the following kinds of information about
> the equipment:
>> a broken part
>> description of symptoms of common
>>   malfunction
>> obvious failure of the equipment to
>>   perform as it should

The reports shall be brief and clearly
understandable, using accepted termi-
nology for the equipment."

> "Given a copy of the appropriate form
> for recording maintenance work done on
> the equipment, on which selected spaces
> are marked, the student will be able to
> go to the equipment (or to manuals de-
> scribing the maintenance procedures),
> determine the information required,
> and properly enter it in the marked
> spaces on the form. The student will
> accomplish this task in X minutes."

2. Serial procedures may be either fixed or
    branching.

    Examples of fixed serial procedures:

    > Energizing a radar set

    > Crew drill in an air defense missile unit

    Examples of variable or branching serial
    procedures:

    > Troubleshooting complex electronic equip-
    > ment using proceduralized methods and
    > job aids.

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Emergency procedures, which often involve
branching away from otherwise fixed serial
procedures.

Guidance: Serial procedures involve a series
of steps, each individual step being relatively
simple to carry out. The learning involved in
serial procedures is learning what follows what,
or chaining of responses. On-the-job serial
procedures are likely to involve both verbal
and motor chains. Verbal chains would involve,
for example, remembering by means of verbal
associations which step comes next at each
stage of the procedure. Motor chaining would
be involved in the actual performance of each
step of the procedure, one after the other, in
a smooth and reasonably rapid fashion.

In the early stages of learning a serial pro-
cedure, a printed or written list of steps may
be used to prompt the student as he or she goes
through the procedure. The person performing
the procedure on-the-job must be able to do so
without looking at such a list. Therefore, the
student must learn the procedure. It may be
helpful in learning the procedure for the student
to verbalize the next step before performing it,
but verbalization should always be kept sub-
ordinate to the actual performance of the pro-
cedure. Nearly always, simply memorizing a
list of steps would be an inefficient and in-
adequate learning activity for serial procedures.

If expensive equipment is involved in the serial
procedure to be learned, this equipment may be
represented during the early stages of learning
by very simple and inexpensive drawings. A line
drawing of the parts of the equipment used in
the procedure, together with a script or schedule
that describes what happens as each step of the
procedure is carried out, can serve the student
very well during much of the time spent learn-
ing a serial procedure. The student can point
to the drawing and describe the action to be
taken at each step of the procedure. In the
final stages of learning, some practice on the
equipment itself will nearly always be required.

In variable or branching procedures, the branch-
ing or decision points are important added
elements. The important things to be learned

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about these decision points are the cues that
give information as to the next step that
should be performed, and of course the set
of steps among which a choice must be made at
each decision point.

3. Tracking and Aiming

Examples: Tracking a target on radar or
with an optical sighting system

Steering a boat to follow a
compass course

Aiming a weapon

Guidance: Whether a moving target is tracked for
some period of time (seconds or minutes) or a
weapon is aimed at a stationary target, the
activity involves continuously changing cues
which must be used to guide the tracking or aim-
ing. The only way that these cues can be pre-
sented to the learner with any degree of realism
is to have the learner track or aim at the target.
Thus the learner must perform the activity of
tracking or aiming to learn it.

The second point to be noted in connection with
tracking or aiming activities is that the learner
must have feedback, i.e., some kind of information
that tells him how accurate his performance is.
In manual tracking on a radar system, an indica-
tion of some kind is provided on a scope so the
operator can see how he is doing. As you steer
a boat, you can see whether the compass pointer
is on the desired course or not, and make correc-
tions as needed. When you aim and fire a weapon,
usually you are able to see whether you have hit
your target or not. If you do not know where on
the target your shots are hitting, learning to
shoot more accurately is almost impossible.

4. Searching and scanning

Examples: Aircraft detection

Aerial observation

Guidance: Searching may be described as examin-
ing an extensive area looking for certain kinds
of objects or patterns. Scanning is a quick
search, subordinate to some other task, such as
scanning the instrument panel while driving a
car.

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The two most important elements in effective searching and scanning behavior are an organized system or routine for searching, and a knowledge of the objects or patterns to be detected. Preliminary familiarization with the objects or patterns to be detected may be given away from a job-like setting by the use of pictures or drawings. Likewise, preliminary instruction on a system or routine for searching can be given in a classroom or other non-job setting. However, these two elements need to be combined in some practice in a job-like setting, in order to be sure that the student is able to perform competently.

5. Discrete or continuous performance

Discrete performances involve a series of steps, where the steps can be described and performed separately.

   Examples of discrete performances:

            Operating control panels in missile systems

            Assembly and disassembly of equipment

Continuous performances cannot be divided into clearly separate steps, and are usually guided and controlled by visual and muscular feedback.

   Examples of continuous performances:

            Aligning or adjusting electronic equipment

            Riding a bicycle

Guidance: Discrete performance has a great deal in common with serial procedures, and the guidance offered under that heading also applies here. However, some kinds of discrete performances may involve steps which are not so simple and easy that the student can readily perform them as soon as he knows what is to be done. In this case, since such steps can be separated from the rest of the performance, specific instruction and practice on these steps may be provided as necessary. The student should be familiar with the overall performance when he or she practices a particularly difficult step, since this overall familiarity helps provide a context for the step, and should make it obvious to the student that this step must be

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learned if the whole performance is to be
successfully accomplished.

Continuous performance is a part of many on-
the-job performances. The most important
feature of continuous performance is that it
depends on visual and muscular feedback—the
continuous flow of information from the eyes
and muscles that tells the brain how well the
performance is going, by comparison to some
standard or goal. Thus in adjusting electronic
equipment, one often looks at a meter or oscillo-
scope while performing a manual adjustment on
the equipment. Both the information that the
eyes provide from the meter or oscilloscope, and
the information that the muscle sense provides
about the adjustment being made ("just a hair
more, now") are necessary to obtain the reading
on the meter or the pattern on the oscilloscope
that tells the student that the adjustment is
satisfactorily completed. In riding a bicycle,
the eyes provide information about the path
ahead and the muscles provide information about
the movements made to control the bicycle. In
this case, additional information is provided
by the sense of balance, which must be integrated
with the information provided by the eyes and
muscles in order to ride the bicycle in a smooth
and controlled fashion.

For training purposes, the important conclusion
that should be drawn from this discussion of
visual and muscular feedback is that the learner
must actually perform the continuous activity so
that he or she can experience this feedback and
learn to respond to it in producing and controlling
the desired continuous performance. Simply tell-
ing the learner about the performance, or having
the learner observe another person performing,
will be quite inadequate for teaching any but
the simplest continuous performances.

6. Noise filtering – detecting cues or symptoms
among background of extraneous stimulation

   Examples: Listening to an engine to detect
                indications of malfunctions

                Detection of targets on a radar
                scope.

   Guidance: Attention should be focused on the
cues or symptoms that are to be detected. If
the equipment or situation can be manipulated
so that the cues or symptoms can be presented

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clearly with a minimum of extraneous stimulation, this would be desirable. When the students have had a chance to perceive the cues or symptoms under these conditions, extraneous stimulation can be introduced to produce the situation that would typically be encountered on the job, and the students could practice, and be tested, on their ability to correctly perceive the cues or symptoms in this situation.

If it is not practical to focus attention on the cues or symptoms in the manner described above, it may be possible to present the student with two different versions of the normal on-the-job situation. In one version, things would be operating normally, with none of the cues or symptoms present. In the second version, the cues or symptoms would be present and the contrast between the two versions, even if rather subtle, should enable the student to focus on the cues or symptoms he or she is to learn to detect.

Noise filtering usually involves detecting sounds or visual patterns. An analogous kind of activity would be involved in selecting relevant information out of a welter of irrelevant information and stimulation, as when an officer must extract the relevant facts concerning an instance of disorderly behavior in his or her subordinates, before deciding on disciplinary or other action. However, the abstract, conceptual nature of this activity properly places it in the problem solving category, and the guidance presented under this category would be more applicable.

7. Skilled actions -- activities that the untrained person cannot perform satisfactorily, even if told what to do.

    Examples: Clutching and shifting an automobile with a manual transmission.

              Precision measurement with a micrometer.

Guidance: The skill involved in activities of the kind to be discussed here is the skill required to carry out complex motor performances smoothly and precisely. Vision may guide the grosser elements of such performances, but smooth, precise performance depends heavily on learning to respond

to the feedback provided by the muscle sense.
This is sometimes referred to as getting the "feel"
of a task. Because the learner must experience
this feedback from the muscle sense, in order to
learn to respond to it with smooth and precise
performance, the learner must practice the per-
formance under conditions realistic enough to
provide this feedback.

Skilled actions, as defined above, may be con-
trasted with actions which the learner can readily
perform as soon as he knows what is required, such
as placing a switch in a specified position, or
adjusting a control so that a specified reading
is obtained on a meter. Most serial procedures
involving discrete performance consist mainly of
steps that the learner can easily perform if he
knows, or is told what to do. Steps that are not
so performed by the learner will be skilled actions
which require the specific and additional practice
referred to in the discussion of discrete per-
formance.

The precise coordination and timing of the several
actions involved in clutching and shifting a manual
transmission automobile or truck must be learned
by practice which allows the learner to experience
the feedback from the muscle sense and to learn to
guide and modulate the actions in response to
this feedback. Engaging the clutch smoothly de-
pends particularly on this feedback. In learn-
ing to make precise measurements with a micrometer,
the learner must learn to respond to the "feel"
of the instrument as he manipulates it, in order
to make consistent, accurate measurements.

8. Discrimination behavior -- recognizing differences
    between objects, indications or examples so
    that different responses can be made to them.

    Examples: Aircraft, tank, or automobile
               identification

               Selecting one answer, example or
               object (Solder joint, for example)
               as the "best" or "correct" one,
               according to certain standards.

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Guidance: The particular elements that are needed to make discriminations should be highlighted in training. Thus, the distinctive features of different aircraft, tanks, or automobiles that are most useful in identification should be pointed out to the student, and practice can be provided with views of the aircraft, tanks, or automobiles in which these features are present. Early in training it may be worthwhile to use views in which these features are particularly prominent. However, such obvious prompting should soon be reduced so that most of the practice and all of the testing are done with views that are representative of actual field conditions.

When the discrimination behavior involves determining whether an item meets a standard, the specifications contained in that standard must be emphasized. Beyond this, however, the student must be able to evaluate the features of the item referred to in the standard and determine whether they meet the specifications. Simply being able to recite the specifications contained in the standard is inadequate; the student must be able to observe the items to be evaluated, and discriminate with the required accuracy those that meet the standard from those that don't. Training for discrimination behavior should therefore include practice and testing using actual examples of the items to be evaluated. The items used in this training should show a range of quality similar to that expected on the job, with the important additional proviso that the unsatisfactory items used in this training should exhibit all important defects that have any significant probability of appearing in the real-life situation.

9. Complex perceptual-motor behavior

 Examples: Driving a car

 Flying an airplane

Guidance: Complex perceptual-motor behavior makes more demands upon training methods and approaches than any kind of performance so far discussed. It may often contain within it many of the kinds of performance described above. Therefore the guidance presented above will be applicable in developing training for complex perceptual-motor behavior, whenever the various kinds of performance discussed above can be identified.

In dealing with the whole problem of training complex perceptual-motor behavior, it may be useful to think of it in three parts:

(a) Giving the student a familiarization with the whole performance, so that the student will have a general frameowrk into which to fit the several more specific kinds of performance that may be involved.

(b) Analyzing the performance to see what parts of it can be extracted for part-training.

(c) Integrating the part-performances into a smooth, proficient overall performance.

Thus, in teaching people to drive a car, it can usually be taken for granted that the American adolescent already has a pretty good general understanding of what is involved in driving a car, including traffic regulations and signals as well as the actual operation of the vehicle. However, if one were training native laborers in an undeveloped part of the world to drive trucks, attention would have to be paid to providing the trainees with some overall framework for understanding the whole performance expected of them after training.

It is likely that many beginning flying students would think only of the activities involved in controlling the aircraft in flight. Therefore, it would be necessary to familiarize them with other elements of the whole performance, such as airspace and route regulations, navigation, communications procedures, aircraft instruments and the uses made of the information they provide, preflight procedures, etc.

In driver training, the information concerning traffic regulations and signals, which is ordinarily covered in the written part of the driver's license examination, can readily be taught separately from the actual operation of the vehicle. In flying training, various kinds of information and regulations are taught in "ground school," before the students learn to operate the aircraft. Usually, whenever knowledge or skill components can reasonably be extracted from the whole complex perceptual-motor performance and taught separately, consideration should be given to doing this. In the case of driving

or flying training, it is obviously important
that students learn the general framework of
traffic and safety regulations and procedures
before they practice the full-fledged perceptual-
motor behaivor of driving or flying. In other
cases, it may be important that specific, addi-
tional practice be given in certain skills, such
as parallel parking a car or making an approach
to an airport, during the learning of the whole
performance.

Complex perceptual-motor behavior involves
coordinating information obtained via the eyes,
ears and other senses to direct motor activity,
and the feedback of information from the muscle
sense and the sense of balance to control the
movements being made. Therefore, it must be
practiced in a reasonably complete form with the
actual equipment used on the job, or on a rela-
tively high-fidelity simulator, if all important
elements of both the perceptual and motor aspects
of the performance are to be produced in the
learner, so that the various part-performances
can be integrated into a smooth, proficient
overall performance. Driving is usually practiced
in the real equipment -- cars. But flying, and
particularly emergency procedures, is often
practiced in elaborate simulators because of
cost and safety considerations. Elaborate and
costly simulators can be better justified for
training complex perceptual-motor behavior than
for any other kind of learning.

10. Problem solving -- recall and application of
    concepts and principles.

    Examples: Troubleshooting complex equipment
               without proceduralized methods and
               job aids.

               Selecting a supervisor for a group
               of workers.

    Guidance: Problem solving behavior may be divided
    into two classes; reproductive problem solving--
    the repeated solving of problems, all of the same
    class; and productive problem solving, a more
    general kind of problem solving in which various
    approaches and methods must be tried until one
    is found that satisfactorily solves the problem.

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The training of <u>reproductive</u> problem solving
can be disposed of quickly. A particular
method of solution can be chosen and designated
as the "correct" method for solving a particular
class of problems. This method can then be taught
and the students given practice in applying it.
Weight and balance computation for a particular
transport aircraft is an example of this kind
of problem solving. It is important in training
this kind of problem solving behavior to give the
students practice on a variety of problems, using
values extending over the ranges likely to be
encountered in on-the-job situations.

<u>Productive</u> problem solving behavior depends on
knowing the concepts and principles (or rules)
that are applicable in the area of work, and on
being able to combine and manipulate these con-
cepts and principles in various ways until a
satisfactory solution is found. Knowledge of
the applicable concepts and principles will
often depend in part on earlier education before
the students entered military service, so that
the capabilities of students entering training
must be carefully assessed--are they proficient
in algebraic operations? Are they acquainted
with the general principles of operation of
spark-ignited internal combustion engines?
Building on the students' prior knowledge, the
additional concepts and principles needed to
solve problems in a given area must be taught,
preferably in the context of work in the area,
rather than as a separate preliminary block of
instruction in, for example, electronics
fundamentals.

The manipulation of concepts and principles in
problem solving behavior occurs, for the most
part, internally or "mentally", and therefore
cannot be observed. One must observe the overt
actions the student takes as a result of this
concept and principle manipulation, and de-
termine whether these overt actions adequately
solve the problem.

A person's ability to manipulate concepts and
principles depends heavily on attitudes and
intellectual skills developed over years of

experience. Is the person excited or challenged
by the problem? What kinds of information gather-
ing and organizing habits has the person developed?
Does the person "keep loose" in his or her think-
ing and is therefore able to shift readily from
unpromising approaches to more promising ones?
Or does the person tend to fixate on a particular
method or approach and rigidly persist in trying
to use it?

Research has shown that simply showing students
the solutions to particular problems does not
work very well as a method of training them to
solve other problems that are somewhat different.
The best methods appear to involve a kind of
guided or prompted discovery process actively
carried out by the students. The kinds of guid-
ance that appear to be most useful in developing
problem solving behavior are as follows:

(a) guidance that warns against using approaches
     that will be unsuccessful

(b) guidance that suggests the <u>general</u> nature
     of approaches that will be successful,
     without telling the student precisely how
     to solve the problem.

To illustrate these guidelines for teaching problem
solving behavior, the relatively simple problem of
a gasoline engine that will not start will be dis-
cussed. Assume that the engine has recently
been operated and that no catastrophe such as total
loss of lubricating oil has occurred, so that major
mechanical difficulties such as frozen pistons or
seized bearings are not likely causes of the prob-
lem. A knowledge of the concepts and principles
involved in a spark ignited internal combustion
engine should enable the student to identify three
likely areas in which the problem solution might
be found: battery and starter system, fuel supply
and carburator operation, and ignition system.
Accordingly, the student should first determine
whether the starter will turn the engine over. If
it will not, possible reasons such as a dead battery
or a faulty electrical circuit to the starter motor
should be investigated. If the engine will turn
over, attention should be directed to the other
systems. Is a spark being delivered to the spark
plugs by the ignition system? Are the spark plugs

shorted? Is the engine out of fuel? Is fuel
getting to the carburetor? Is the fuel pump
operating? Is the choke closed (for a cold
engine)? Is there excess gasoline in the car-
buretor ("flooded")? The student will need to
understand the meanings of such questions and
know where and how to obtain the information to
answer them. Questions or prompts of various
kinds may be used to nudge the student down the
path to discovering the reason that the engine
will not start. Essentially, the student must
engage in the process of organizing and direct-
ing his information seeking efforts (which is
mainly a covert or internal process), and must
know what should be done if certain conditions
are found, if he or she is to develop any gen-
eralized problem solving capability in this area.

As a second illustration of how problem solving
may be taught, consider a problem from a very
different area, that of selecting a supervisor
for a group of workers. Problem solving in this
area would usually be taught by using hypothetical
cases to stimulate the covert manipulation of
concepts and principles in which the students
must engage. The students would be given infor-
mation about the kind of work done by the group
of workers, and perhaps some general restric-
tions within which the problem was to be solved.
Attention might then be directed to the question:
What do you expect the supervisor to do? Dis-
cussion of possible answers to this question
should define the concept of supervision to be
used in this case. Must the supervisor be expert
in performing the work done by the workers? Does
the supervisor organize the work group and assign
work, based on requirements handed down from
higher management? Does the supervisor represent
the workers in the group to higher management
levels, arguing for them in matters that affect
the group? Etc. Attention might then be turned
to the characteristics of the candidates for the
job of supervisor. The students should be en-
couraged to obtain information on each of the
candidates that is relevant to the elements of

the concept of supervision, and to compare the
characteristics of each candidate with performance
requirements implicit in the concept of super-
vision decided upon. The question that should
be asked (usually covertly) in making these
comparisons is "Can this candidate perform
acceptably as we expect a supervisor should?"

These two examples are relatively simple and
structured, compared to many kinds of __productive__
problem solving. Sometimes the manipulation of
concepts and principles must proceed over quite
uncharted ground. The important thing in train-
ing for problem solving, however, is that students
must be stimulated to engage in this manipula-
tion under circumstances that are similar to
those that will be involved in problem solving
situations on the job.

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REFERENCES

Air Training Command, USAF, Training Plans, ATC Manual 52-1, 15 September 1969.

Department of the Air Force, AF Pamphlet 50-58, Handbook for Designers of Instructional Systems. 15 July 1973.

Department of the Air Force, AF Manual 50-2, Instructional System Development, 31 July 1975.

Gagne, Robert M. The Conditions of Learning (2nd edition), New York: Holt, Rinehart and Winston, 1970.

Gagne, Robert M. and Briggs. Leslie J. Principles of Instructional Design. New York: Holt, Rinehart and Winston, 1974.

Haverland, Edgar M. Transfer and Use of Training Technology: A Model for Matching Training Approaches with Training Technology, Alexandria, Va.: Human Resources Research Organization, Technical Report 74-24, October 1974.

Haverland, Edgar M. and Hungerland, Jacklyn E. Transfer and Use of Training Technology in Air Force Technical Training: A Progress Report. Alexandria, Va.: Human Resources Research Organization, Interim Scientific Report IR-ED-75-24, October 1975.

Hungerland, Jacklyn E., Taylor, John E., and Brennan, Mark F. Utilization of Peer Instruction in Air Force Technical Training. Alexandria, Va.: Human Resources Research Organization, Final Report FR-WD-CA-76-12, August 1976.

Weingarten, Kenneth, Hungerland, Jacklyn E., and Brennan, Mark F. Development and Implementation of a Quality-Assured, Peer-Instructional Model. Alexandria, Va.: Human Resources Research Organization, Technical Report 72-35, November 1972.